

What is claimed is:

1. A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer; and
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer.
2. The method of claim 1, wherein the dual-purpose layer comprises a material capable of reducing diffusion of the conductive interconnect material into surrounding materials, and wherein the dual-purpose layer comprises a material having a resistivity that allows electrochemical deposition of the conductive interconnect material.
3. The method of claim 1, wherein the dual-purpose layer comprises a material selected from the group consisting of tungsten, tungsten nitride, and tungsten-silicon nitride.
4. The method of claim 1, wherein the material comprising the dual-purpose layer comprises tungsten.
5. The method of claim 1, wherein the conductive interconnect material comprises copper.
6. The method of claim 1, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.

7. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

8. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

9. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

10. A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer in an electrochemical reaction cell comprising an anode formed from a material that can be oxidized in the presence of the material comprising the dual-purpose layer; and
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer.

11. The method of claim 10, wherein the anode is formed from titanium or titanized platinum.

12. The method of claim 10, wherein the electrochemical reaction cell contains a first electrolyte comprising the cation of the material used to form the anode.

13. The method of claim 10, wherein the anode comprises titanium and the first electrolyte comprises titanium trichloride, titanium sulfate, titanium bromide, titanium trichloride, titanium iodide, titanium fluoride, or mixtures thereof.
14. The method of claim 13, wherein the first electrolyte comprises titanium trichloride or titanium sulfate.
15. A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer utilizing a first electrolyte; and
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer utilizing a second electrolyte.
16. The method of claim 15, wherein the electrochemically reducing step is performed in a first electrochemical reaction cell and the electrochemically depositing step is performed in a second electrochemical reaction cell.
17. The method of claim 15, wherein the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell.
18. The method of claim 15, wherein the electrochemical reducing step is performed using a first anode and the electrochemical depositing step is performed using a second anode.
19. The method of claim 15, wherein the electrochemical reducing step and the electrochemical depositing step are performed using a single anode.

20. The method of claim 15, wherein the dual-purpose layer comprises a material selected from the group consisting of tungsten, tungsten nitride, and tungsten-silicon nitride.
21. The method of claim 15, wherein the material comprising the dual-purpose layer comprises tungsten.
22. The method of claim 15, wherein the conductive interconnect material comprises copper.
23. The method of claim 15, wherein the first anode comprises a material that can be oxidized in the presence of the material comprising the dual-purpose layer.
24. The method of claim 15, wherein the first anode is formed from titanium or titanized platinum, platinum, or copper.
25. The method of claim 15, wherein the first electrolyte contains the cationic species of the material comprising the first anode.
26. The method of claim 15, wherein the first electrolyte comprises titanium sulfate, titanium bromide, titanium trichloride, titanium iodide, titanium fluoride, copper sulfate, or mixtures thereof.
27. The method of claim 15, wherein the first anode is formed from titanium and the first electrolyte is titanium chloride or titanium sulfate.
28. The method of claim 15, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the

electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.

29. The method of claim 15, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

30. The method of claim 15, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

31. The method of claim 15, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both electrochemically reducing step and the electrochemically depositing step.

32. The method of claim 15, wherein at least one of the electrolytes comprises:
the cation of the material from which the conductive interconnect layer is made;
a complexing agent; and
a pH control agent.

33. The method of claim 32, wherein the conductive interconnect layer comprises copper and the electrolyte comprises copper sulfate.

34. The method of claim 32, wherein the complexing agent is selected from the group consisting of ethylene diamine tetra acetate, boric acid, and malonic acid.

35. The method of claim 32, wherein the complexing agent is ethylene diamine tetra acetate.
36. The method of claim 32, wherein the pH control agent is tetramethyl ammonium hydroxide, ammonium hydroxide, or potassium hydroxide.
37. The method of claim 32, wherein the pH control agent is tetramethyl ammonium hydroxide.
38. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 7.
39. The method of claim 32, wherein the electrolyte exhibits a pH greater than or equal to about 10.
40. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 7 and less than or equal to about 12.
41. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 10 and less than or equal to about 12.
42. A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer; and
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer, wherein both the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell utilizing a single electrolyte.
43. The method of claim 42, wherein the dual-purpose layer comprises tungsten.

44. The method of claim 42, wherein the electrolyte comprises:
the cation of the material from which the conductive interconnect material is made;
a complexing agent; and
a pH control agent.
45. The method of claim 44, wherein the conductive interconnect material comprises copper and the electrolyte comprises copper sulfate.
46. The method of claim 44, wherein the complexing agent is selected from the group consisting of ethylene diamine tetra acetate, boric acid, and malonic acid.
47. The method of claim 44, wherein the complexing agent is ethylene diamine tetra acetate.
48. The method of claim 44, wherein the pH control agent is tetramethyl ammonium hydroxide, ammonium hydroxide, or potassium hydroxide.
49. The method of claim 44, wherein the pH control agent is tetramethyl ammonium hydroxide.
50. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 7.
51. The method of claim 44, wherein the electrolyte exhibits a pH greater than or equal to about 10.
52. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 7 and less than or equal to about 12.

53. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 10 and less than or equal to about 12.

54. The method of claim 42, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.

55. The method of claim 42, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

56. The method of claim 42, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

57. The method of claim 42, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

58. An electrochemical reaction cell comprising:
an electrical power source;
a cathode electrically connected to the electrical power source;
an anode electrically connected to the electrical power source and the cathode; and
an electrolyte comprising:
a metal cation;
a counterion;

a complexing agent; and
a pH control agent.

59. The electrochemical reaction cell of claim 58, wherein the cathode comprises a substrate having a surface layer containing tungsten.

60. The electrochemical reaction cell of claim 58, wherein the metal cation is a cation of copper.

61. The electrochemical reaction cell of claim 58, wherein the metal cation and the counterion together comprise copper sulfate.

62. The electrochemical reaction cell of claim 58, wherein the complexing agent is selected from the group consisting of ethylene diamine tetra acetate, boric acid, and malonic acid.

63. The electrochemical reaction cell of claim 58, wherein the complexing agent is ethylene diamine tetra acetate.

64. The electrochemical reaction cell of claim 58, wherein the pH control agent is tetramethyl ammonium hydroxide, ammonium hydroxide, or potassium hydroxide.

65. The electrochemical reaction cell of claim 58, wherein the pH control agent is tetramethyl ammonium hydroxide.

66. The electrochemical reaction cell of claim 58, wherein the electrolyte exhibits a pH greater than about 7.

67. The electrochemical reaction cell of claim 58, wherein the electrolyte exhibits a pH greater than or equal to about 10.

68. The electrochemical reaction cell of claim 58, wherein the electrolyte exhibits a pH greater than or equal to about 7 and less than or equal to about 12.

69. The electrochemical reaction cell of claim 58, wherein the electrolyte exhibits a pH greater than or equal to about 10 and less than or equal to about 12.

70. A semiconductor, comprising:

a conductive interconnect layer electrochemically deposited onto a dual-purpose layer.

71. The semiconductor of claim 70, wherein the dual-purpose layer contains tungsten.

72. The semiconductor of claim 70, wherein the dual-purpose layer is tungsten, tungsten nitride, or tungsten-silicon nitride.

73. The semiconductor of claim 70, wherein the dual-purpose layer is tungsten.

74. The semiconductor of claim 70, wherein the conductive interconnect layer is copper.

75. A memory device, comprising:

an address decoder;

row access circuitry;

column access circuitry;

control circuitry;

an input output circuit; and

an array of memory cells, wherein at least one of the memory cells comprises a conductive interconnect layer electrochemically deposited onto a dual-purpose layer.

76. The memory device of claim 75, wherein the dual-purpose layer contains tungsten.

77. The memory device of claim 75, wherein the dual-purpose layer is tungsten, tungsten nitride, or tungsten-silicon nitride.

78. The memory device of claim 75, wherein the dual-purpose layer is tungsten.

79. The memory device of claim 75, wherein the conductive interconnect layer is copper.

80. A semiconductor die produced from a semiconductor wafer, comprising:
an individual pattern on a substrate that contains circuitry or integrated circuit devices, wherein the circuitry or integrated circuit device performs a specific function, and wherein at least one of the integrated circuit devices comprises a conductive interconnect layer electrochemically deposited onto a dual-purpose layer.

81. The semiconductor die of claim 80, wherein the dual-purpose layer contains tungsten.

82. The semiconductor die of claim 80, wherein the dual-purpose layer is tungsten, tungsten nitride, or tungsten-silicon nitride.

83. The semiconductor die of claim 80, wherein the dual-purpose layer is tungsten.

84. The semiconductor die of claim 80, wherein the conductive interconnect layer is copper.

85. A circuit module, comprising a combination of two or more semiconductor dies, to form a circuit module for enhancing or extending the functionality of an individual semiconductor die, wherein one or more of the semiconductor dies comprises a conductive interconnect layer electrochemically deposited onto a dual-purpose layer.

86. The circuit module of claim 85, wherein the dual-purpose layer contains tungsten.

87. The circuit module of claim 85, wherein the dual-purpose layer is tungsten, tungsten nitride, or tungsten-silicon nitride.

88. The circuit module of claim 85, wherein the dual-purpose layer is tungsten.

89. The circuit module of claim 85, wherein the conductive interconnect layer is copper.

90. An electronic system, comprising:

one or more circuit modules and a user interface, wherein at least one of the circuit modules comprises a conductive interconnect layer electrochemically deposited onto a dual-purpose layer.

91. The electronic system of claim 90, wherein the dual-purpose layer contains tungsten.

92. The electronic system of claim 90, wherein the dual-purpose layer is tungsten, tungsten nitride, or tungsten-silicon nitride.

93. The electronic system of claim 90, wherein the dual-purpose layer is tungsten.

94. The electronic system of claim 90, wherein the conductive interconnect layer is copper.

94. The electronic system of claim 90, wherein the conductive interconnect layer is copper.